Original Article

Testing protocol for monitoring upper-body strength using medicine balls

JOSÉ MANUEL PALAO[1] , DAVID VALDÉS[2]

[1]Faculty of Sport Science, University of Murcia, Murcia, Spain

[2] Faculty of Medicine and Health Sciences, University of de Alcalá, Madrid, Spain

ABSTRACT

Palao JM, Valadés D. Testing protocol for monitoring upper-body strength using medicine balls. *J. Hum. Sport Exerc.* Vol.8, No. 2, pp. 334-341, 2013. The purpose of this paper is to present a specific testing protocol for monitoring upper-body strength using medicine ball throws. The protocol is composed of three tests: throw without countermovement, throw with countermovement, and throw with countermovement of a medicine ball drop. These tests are done from a lying position and involve throwing overhead with both arms. This paper provides the characteristics of the tests (warm-up, organization, execution, rest, etc.) as well as possible applications of the protocol. **Key words**: MONITORING, TESTS, POWER, THROW, MEDICINE BALL.

Corresponding author. University of de Alcalá. Faculty medicine. Campus Universitario, Ctra. Madrid-Barcelona Km 33,600. 28871 Alcalá de Henares (Madrid). Phone number: 91 885 48 55
E-mail: david.valades@uah.es
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INTRODUCTION

Monitoring strength in sport is common. There are two types of protocols for testing strength: a) general tests (i.e. measuring strength and power in the laboratory or weight room); and b) specific tests (i.e. measuring the application of this strength in a specific sport and/or situation). In the literature, there are more tests for general situations than for applied situations. This is likely because tests done in controlled situations are more reliable, valid, and objective (Baumgartner et al., 2003; Lacy & Hastad, 2006). However, in order to be useful, it is also necessary to consider the applicability of the test or protocol. For example, a general test for lower body strength/power, such as the weight lifted in a 1-3 repetitions test in the squat, allows strength and conditioning professionals to monitor an athlete´s progress and design weight training workouts at the same time (Cramer & Coburn, 2004; Fleck & Kramer, 2000; Kramer et al. 1988; Logan et al., 2000). Another example is the Bosco Tests that can provide information about the athlete´s progression and ability to apply different types of strength manifestations (Bosco, 1992; Komi & Bosco, 1978). This testing protocol is composed of various tests (e.g. squat jump without countermovement, countermovement jump, drop jump test, etc.). Through the comparison of the data (height jump) from the different tests of the protocol, the strength and conditioning coach can obtain information about the ability of the athlete to apply different types of strength manifestations (Bosco, 1992; Komi & Bosco, 1978). Each test provides information about one strength manifestation (Figure 1). Comparing the information from the different tests, the strength and conditioning coach can determine the aspects that need to be improved.

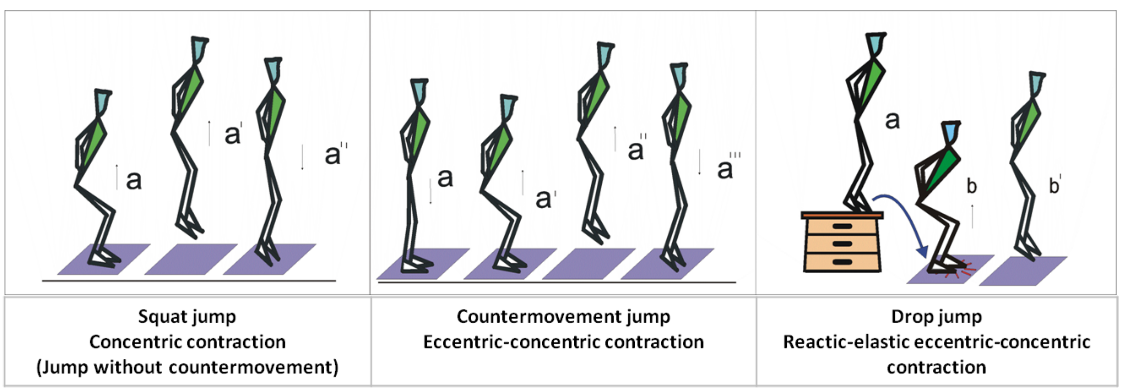

Figure 1. *Bosco Tests.*

Adapting the Bosco Tests to the common medicine ball throw test, this paper presents a protocol of progressive tests for the upper body. The goal of the protocol is to obtain information about the strength ability of the athletes through progressive tests, such as in the Bosco Tests. The idea is simply to become familiar with the ability of the athlete to apply force in different situations which allows strength and conditioning professionals to monitor athletes and guide the training process. The protocol accurately and indirectly monitors the ability to utilize upper-body strength/power in athletes of volleyball, baseball, team handball, etc. from the distance thrown in the medicine ball tests.

TEST DESCRIPTIONS

The medicine ball throw protocol is composed of three tests (Test 1: Concentric throw, Test 2: Eccentric-concentric throw, and Test 3: Reactive-elastic eccentric-concentric throw). These tests progress from general to specific with regard to the ability to utilize strength/power. In Test 1 (Table 1), a throw without

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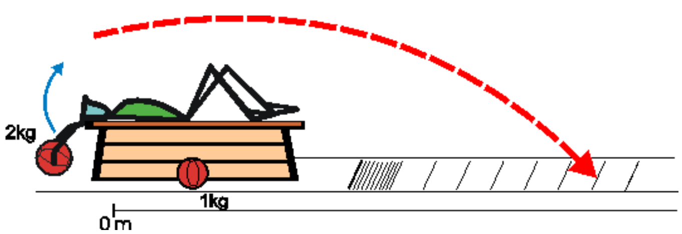
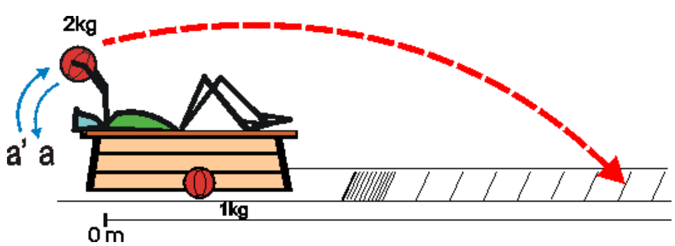
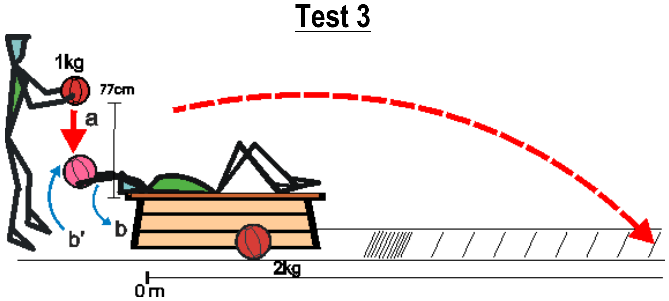
countermovement, athletes apply their strength/power to a 2kg medicine ball with their shoulders and elbows extended. This test aims to evaluate the ability to utilize strength/power using a concentric contraction of the upper body (with regard to the actions of the shoulder, elbow, and wrist). In Test 2 (Table 1), a throw with countermovement, athletes throw a 2kg medicine ball while first flexing and then extending the shoulders and elbows. This test gives information about the ability to utilize the eccentric-concentric cycle.

Table 1. *Description of the protocols of medicine ball test for monitoring upper body strength*

Test 1 	-Athlete throws a 2 kg medicine ball as far as possible. Ball is thrown with an extension movement. Athlete´s back is always in contact with the bench. The distance is measured from athlete's shoulders. Purpose: to evaluate the ability to utilize strength/power using a concentric contraction of the upper body (regarding the actions of the shoulder, elbow, and wrist).
Test 2 	-Athlete a 2 kg medicine ball as far as possible. The ball is thrown with a flexion-extension movement. Athlete´s back is always in contact with the bench. The distance is measured from athlete's shoulders. Purpose: to evaluate the ability to utilize the eccentric-concentric contraction of the upper body (regarding the actions of the shoulder, elbow, and wrist).
Test 3 	-Athlete throws a 1 kg medicine ball as far as possible. The ball is dropped by a strength coach or teammate from a height of 0.77 meters. The ball is thrown with a flexion-extension movement. Athlete´s back is always in contact with the bench. The distance is measured from athlete's shoulders. Purpose: to evaluate the ability to utilize the reactive-elastic eccentric-concentric contraction of the upper body (regarding the actions of the shoulder, elbow, and wrist).

In Test 3 (Table 1), a throw with countermovement after receiving a dropped 1kg medicine ball, athletes throw the medicine ball after a strength coach or teammate dropped it to them from a distance of 0.77 meters from the bench (Ebben et al., 1999). This test evaluates the application of the reactive-elastic eccentric-concentric cycle. A reduction of one kilogram is done in the ball weight in test 3, so the vertical impact force of the ball that is dropped is equal to the force of the balls in tests 1 and 2 (Ebben et al., 1999).

TESTING PROTOCOL

The testing protocol should be done after general and specific warm-ups (5-10 min of jogging, movements using active stretches that are specific to the throw, and different types of throws with the medicine ball). Before the tests, athletes do three practice trials. A minimum of 30 seconds of rest between trials should be taken (Gaitanos et al., 1993). In the throws, athletes cannot vary their throwing position. The weight of the medicine ball is two kilograms for tests 1 and 2 and one kilogram for test 3. The athletes´ back has to be in contact with the bench the entire time. The best of three trials is recorded (distance reached in the throw measured from the athlete´s shoulders. If none of the three trials are correctly executed, a maximum of five trials should be completed per test.

For the test proposal, several adaptations can be done according to the different needs of the sports, teams, athletes, etc. The tests can be done from different positions (standing or sitting; Figure 2), using different weights, etc. The difference in the proposed positions for execution is the use or possibility of using the kinetic chain of the upper body and lower body. When adapting the tests, due to the involvement of the trunk, it is important for the starting position to be in the same position for all the tests. In both cases, it is possible to limit the trunk and low-body participation using an object such as a chair to limit the athlete´s back movement.

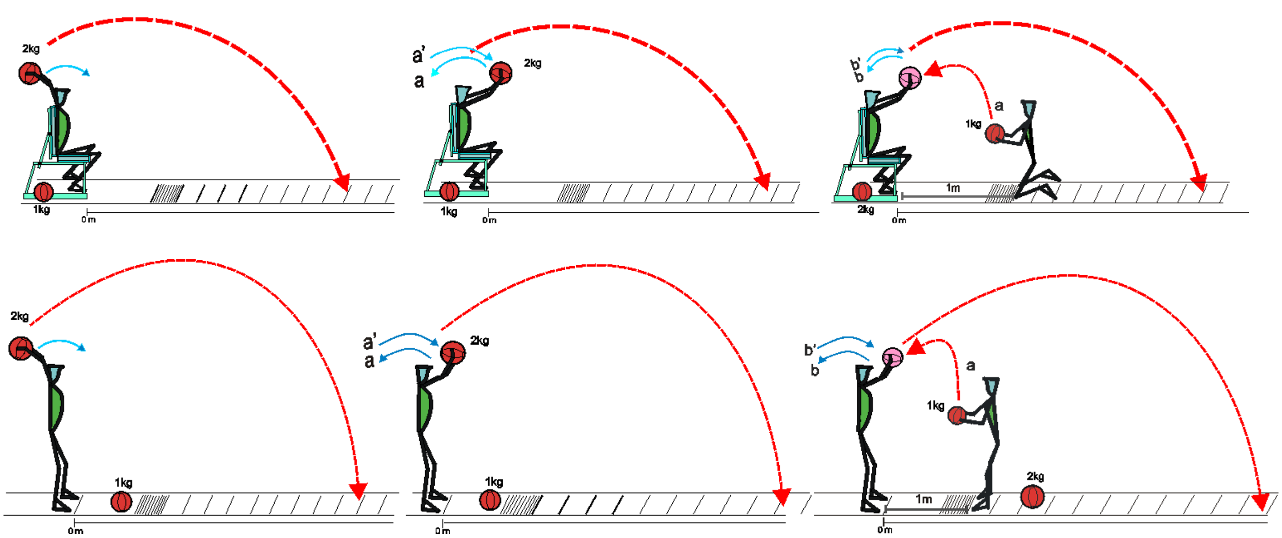


***Figure 2**. Adaptation of the proposal of protocol test - Throw from standing position and sitting position*
(Test 1 - Concentric throw / Test 2 - Eccentric-concentric throw / Test 3 - Reactive-elastic eccentric-concentric throw)

Adapting the weight and size of the medicine ball must be in relation to the characteristics of the ball or implement used in the sport. However, medicine balls of different weights can be used to measure the

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ability to apply strength in different situations. The drop height and the weight affect the vertical impact force in the negative phase of the drop throw (Ebben et al., 1999). If the weight of the medicine ball is changed, the drop height has to adapt so there is an equal force involved in throwing the medicine balls in the different tests (Table 2).

Table 2. *Description of the medicine ball test protocol for monitoring upper body strength*

Weight of medicine ball	Drop height	Vertical impact force
1 Kg	0.77 m	2 Kg
2 Kg	0.68 m	3 Kg
3 Kg	0.60 m	4 Kg
4 Kg	0.50 m	5 Kg
5 Kg	0.41 m	6 Kg

The execution of the tests with one or two hands depends on whether the purpose is to measure the bilateral or unilateral upper-body strength application. The take-off angle can be changed according to the characteristics of the sport discipline. In this case, a zone where the ball must pass through should be placed to assure that the angle of the throw is the same as a given action in the sport discipline. If this zone is positioned too far from the player, the precision would not allow players to apply all of their strength. For a discipline such as the javelin, athletes should attempt a maximal distance throw without restriction. In sports such as baseball or team handball, the angle should be horizontal to the floor, although this affects the distance that is achieved. However, in volleyball, where the angle of execution involves sending the ball directly to the floor, it is necessary for the test to be done while lying on a bench.

APPLICATIONS

The medicine ball test protocol attempts to evaluate and provide information about the ability of the players to apply strength/power. Medicine ball throwing correlates with upper-body strength as well as with throwing and hitting ability (Davis et al., 2008; Debanne & Laffaye, 2011; Häkkinen, 1993; Stockbrugger & Haennel, 2001; Viitasalo, 1988). The values that are obtained with these tests will give coaches a point of reference and help them with strength/power work and with monitoring their athletes´ training. For example, these tests will help detect whether or not a player adequately applies strength/power through different tests from the battery (concentric, eccentric-concentric, and reactive-elastic eccentric-concentric cycle). The data from the different tests give information about the individual needs in the strength/power work. Table 3 shows the proportional difference in distance thrown between the tests of this protocol.

Table 3. *References for the proportional variation of the distance thrown between the various tests of the protocol (data obtained from Ignjatovic et al., 2011; Shinkle et al., 2012; Valades, 2005)*

Test 1: Concentric throw	Test 2: Eccentric-concentric throw	Test 3: Reactive-elastic eccentric-concentric throw
0%	+4-8%	+6-10%

The tests can be done consecutively or individually in order to fulfill the coach's objectives. For example, the coach may only be interested in measuring the reactive eccentric-concentric cycle test value. Coaches can adapt the test to their interests and needs by creating variations such as comparing bilateral throws with unilateral throws, etc. Executing the tests from different positions allows strength and conditioning professionals to obtain information about the ability of the athletes to apply the kinetic chain and to monitor possible deficits in the athlete´s execution. This information will also help strength and conditioning professionals review the mechanics of the execution of the throws.

Follow-up testing during the season will allow coaches to monitor variations in upper-body strength. The information regarding changes in this protocol will help to evaluate the effect of strength/power work for the upper body. This will provide information about whether conditioning and practices are having a positive effect on performance or whether there is a decrease in performance during the season. Protocol application will allow coaches to detect deficiencies in contractile abilities in upper-body or core strength and power. Tests 1 and 2 demonstrate an athlete´s ability to apply strength through concentric contraction and eccentric-concentric contraction. Test 3 demonstrates the ability to apply strength/power when using reactive eccentric-concentric contraction. This protocol can be used as a whole (applying the three tests) or individually, according to the type of strength manifestation that the strength and conditioning professionals want to monitor. These tests can be used with athletes at different levels (high school, college, or professional teams). Base values should be established for each athlete for every level of competition. For example, if a volleyball player is tested and differences are found between Tests 2 and 3, the strength and conditioning coach can determine whether her or his athlete has problems with their plyometric ability (the use of elastic energy) and can plan this type of training to correct this deficit.

The proposed adaptations give strength and conditioning professionals the possibility to do a deeper study of the strength abilities of the athletes. Throwing from different positions allows for assessing the ability of the athlete to apply the kinematic chain. The use of medicine balls of different weights allows strength and conditioning professionals to calculate a weight-distance curve. Figure 3 presents an example of the weight-distance curve from a test of the protocol that was done with different weights. The weight of the medicine ball is set on the y-axis and the distance that is reached is on the x-axis. The curve that is obtained gives information about the athlete`s upper-body strength. If the curve is steeper, it shows that the athlete has maximal strength ability, and if the curve is flatter, it shows that the athlete has adequate explosive strength ability. Throughout the season, an increase in the left side of the curve (higher weight) shows an increase in the maximal strength ability, and an increase in the right side of the curve (lower weight) shows an increase in the explosive strength ability.

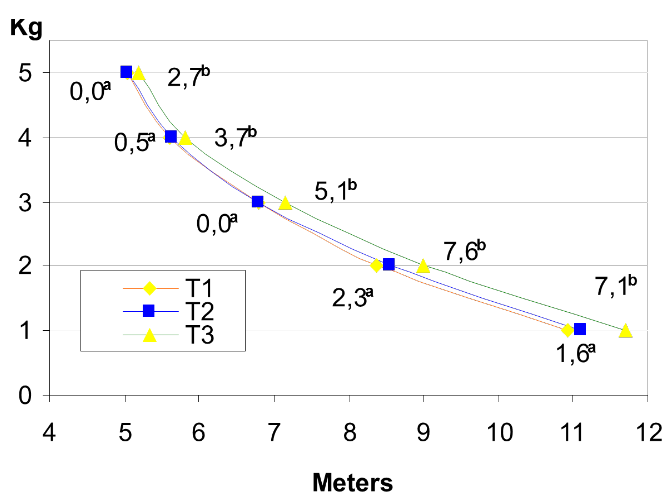

Figure 3. *Example of weight-distance curve of a test of the protocol of medicine balls throws in three moments of the season T1, T2, & T3 (Valadés, 2005).*

Legend: a is the percentage of increase (∆%) between T1 and T2; b is the percentage of increase (∆%) between T2 and T3.

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The data obtained in these tests can be used as reference values to monitor upper-body strength training with medicine balls. This type of work allows strength and conditioning professionals to work on strength application in situations comparable to those found in the sport, using little material and conditions that are similar to those of competition.

CONCLUSIONS

This protocol of throwing tests can allow strength and conditioning professionals as well as other coaches to monitor the effect of upper-body strength/power training and the use of this strength. The protocol can be utilized as a whole or be adapted to the characteristics of the athletes and their necessities (sport, level, time for testing, etc.). The fact that the tests progressively evaluate execution of the throw (manifestation of muscle contraction) means that coaches are able to detect possible deficits in upper-body strength/power from the differences between the tests. The tests can provide information to orientate upper body strength/power workouts.

The tests provide coaches with the possibility of monitoring the progression and level of their players with regard to upper-body strength/power by monitoring athletes' performances during the season. This paper presents a specific strength testing protocol for monitoring the applied strength. This protocol, combined with the monitoring of lower-body strength/power, will allow coaches to measure the ability to utilize strength in sports such volleyball, team handball, water-polo, or track and field (ex. javelin).

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